EXAMINING EFFECTS OF CHANGES IN POPULATION DENSITY ON ECONOMIC GROWTH IN KENYA

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DECLARATION

This project is my own work and has not been submitted for any award in any other university.

Signature: ………………………………. Date: ………………………………..

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This research project has been submitted for examination with my approval as the university supervisor.

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DEDICATION

I dedicate this project to my family and Kenyans who are putting their efforts in promoting economic prosperity in Kenya.

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ABBREVIATIONS AND ACRONYMS

AIC	Akaike Information Criterion
ARDL	Autoregressive Distributed Lag Model
CUSUM	Cumulative Sum of Recursive Residuals
CUSUMSQ	Cumulative Sum of Squares of Recursive Residuals
ECM	Error Correction Model
GDP	Gross Domestic Product
ICSW	International Council on Social Welfare
LCB	Lower Critical Bound
OLS	Ordinary Least Squares
SBC	Schwarz Bayesian Criterion
UCB	Upper Critical Bound
UK	United Kingdom
UN	United Nations
US	United States

ABSTRACT

Population density plays a great role for economic activities. Population densities are ignored as economic variables in analysis as countries that have same macroeconomic variables but differences in population densities are categorized similar. Population densities contribute greatly in gathering societies particularly those which have reliance on natural resources and farming. This paper explores how changes in population density affect economic growth in Kenya. Also, the study examines how changes in working age and dependent population influence economic growth in Kenya. The study utilizes time series secondary data obtained from Penn World table 9.1 and World Bank Development Indicators for the period 1981 to 2017 and employs ARDL bounds procedure. The findings indicate that: (i) population density growth has a significant positive impact on economic growth. (ii) Working age population growth has a significant negative impact on economic growth. (iii) Dependent population growth has a positive impact on economic growth. The results suggest that policies geared towards improving technological and physical infrastructure, reducing unit transport costs and creating competition among producers in Kenya should be encouraged. Efforts should be put also to enhance creation of decent and adequate job opportunities to absorb and utilize the working population. Collaboration and support on the job and need based training should be enhanced to mitigate on mismatch between workforce skills and new employment opportunities. Lastly, the retirement age for the productive working age should be extended as they contribute positively to economic growth.

DEFINITION OF TERMS

Population density - World Bank defines population density as the mid-year population divided by land area (usually in square kilometres). These statistics represent all people who live in a land area. They exclude refugees and other temporary residents but include illegal immigrants. Land area does not include water masses like major lakes and rivers.

Gross Domestic Product - This is nation's total economic output and measures final production. It includes government expenditures, consumption, net exports and investment.

Economic growth – This is growth in GDP from a time period to another. It can be measured quarterly or yearly either in real or nominal terms.

Working age population- This is the total population in a country that is aged 15-64 years and is able and likely to work.

Dependent population- This is the population aged 0-14 years and 65 years and above.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Population densities of most countries have been considerably rising over the past years but vary greatly across the globe as a result of both geographical and endogenous factors (Arthur 1994). Notably, the increasing population density has been consistent with living standards. However, there are arguments that a population density which is high can contribute to unwelcome effects due to pressures of people on available limited resources such as agricultural land. Krugman (1996) and Fujita et al (1999) associated higher population concentrations with increased intensity of agglomeration economies.

Most part of economic theory has not taken into account the contribution population density plays for economic activities. Population densities are ignored as economic variables in analysis. Ladd (1992) studied the effects that population density has on local public spending. Even though most planners claim that population density is good in the production of certain services due to density economies, she found empirically J-curve per capita spending. This clearly showed why cost per capita are high at low population densities and why they decline as population density increases. Population densities contribute greatly in gathering societies especially those who rely on farming and natural resources. Yegorov (2009) argued that a population density which is too high reduces per capita natural endowment but facilitates infrastructure expansion which leads to an optimal density for economic growth. Competition might be rare in countries with low population densities because investors can become insolvent as a result of low demand for products and high costs of transport. Therefore, population density plays a crucial role for an ideal country's size. A nation's land area is regarded as a capital fetching rent from extraction of natural resources. Border protection and community cost are also influenced by population density.

In 2011, the world's population was growing by an additional 82 million people each year and had surpassed 7 billion (United Nations, 2013a). Majority of developing nations are lowering population growth rates so that they can ease pressure on available resources, prevent food scarcities, offer decent work and provide basic services to their citizens. Therefore, majority of these countries have appreciated that operational application of population policies involves an organized structure that guarantees the incorporation of population parameters in development planning with suitable monitoring and evaluation mechanisms. Over the years, fertility and mortality rates have decreased causing unprecedented variation in population age structure. Different countries are therefore affected differently depending on their level of development and stage of demographic change. Nations with older age structures and low shares of youth and working age adults experience adverse effects of labour supply and old age social protection programs. Most developing countries are experiencing rising numbers of youth and working age people which can, if properly utilized, lead to demographic bonus in the short run. However, this can also bring challenges in creating employment opportunities and providing education. Increase in long life and reduction in fertility may lead to population aging where the aged (older persons) become a relatively large portion of the whole population. This creates a weighty effect on the economy through labour supply and employment, intergenerational transfers, pension schemes, savings and investment. There are growing concerns about the feasibility of intergenerational social assistance which is critical for the prosperity of the younger and older generations (Cliquet et al 1999; International Council on Social Welfare, 2010).

1.1.1 Global and Regional Perspectives on Population Density

In different parts of the world, there are varying population densities. The 2007 Demographic Year Book of the United Nations recorded that the world population density was 49 persons per km^2. Oceania had a density of 4 persons per squared kilometer, North America (16), South America (28), Africa (32), Europe (32) and Asia (126). Even among the continents, there are noted outstanding disparities in population concentration at both sub-national and national levels. There is general reduction of birth rates in the world due to improvements in sanitation and health care. The world population is growing rapidly due to presence of high birth rates in many less developed countries. A variety of physical and human factors influence population density. Countries with good topography, availability of natural resources and favorable climate tend to attract large number of people and therefore tend to be densely populated. Additionally, nations with politically stable governments tend to be densely populated compared with politically unstable countries where people migrate for their safety and survival. People are also attracted to areas with high social cohesion and availability of well-paying job opportunities.

1.1.2 Population Density and Economic Development.

Ancient social theories suggested that increased technological invention led to societal progress as a result of competition and specialization. Some nations are pre-industrial nations where population pressures have exacted population to undergo societal progress through development of institutions, advanced agrarianism and socio-spatial efficiencies.

In essence, population density was a suitable indicator as the beginning line for the current race of growth of economies. This view is strengthened by observing that each industrialized nation has a history of advanced social or political movement which improved the economic status of the farmer, either through social revolution or settler colonies and direct transfer of agrarianism to new regions. Lenski and Nolan (1994) identified that agriculture produces economic surplus which facilitated existence of densely settled population, introduction of written language and monetarism. Proto-modern societies display spatial and social characteristics that are directly linked to their demographic traditions leading them to rapid progress upon acquaintance to external and modern technology.

Traditionally, population density has an inverse relationship with farm size as increase in population density leads to continuous subdivision of land. Over the years, many developed farming systems returned to small holding communities where more people derived their subsistence from a lesser amount of arable land (Boserup 1965). Berry and Cline (1979) observed that there was tendency for small firms to utilize land more productively. Modern evidence proposes that increased levels of agricultural surplus and intense competition for land lead to specialization, increased non-farm employment and renewed innovation (Boserup 1990; Clark 1967; World Bank 1978). Historically, dense communities are less likely to be burdened by harsh economic inequalities. Communities with low levels of political/economic development and low densities of population attracted colonization and subsequent disparities in capital and land (e.g. Africa and Latin America).

Densely populated areas encourage permanent settlements which promote improved trade, communication, education and literacy. Additionally, dense settlements support development of necessary infrastructure which include roads and ports (Glover and Simon, 1975). According to Kriedte, Peter, Hans and Jurgen (1981), dense settlement patterns and linking infrastructure development inspire widening of cottage industries and commercial farming which is key pre-cursor to industrialization. Increasing population density leads to specialization which expands the number of social transactions and quickens division of labor. Acemoglu, Daron and James (2002) argued that European colonization and discerning venture brought about institutional arrangements that overturned the affluence of the ancient farming kingdoms. Their evidence illustrates a negative relationship between population density estimates in A.D. 1500 and the level of economic development. However, ancient records relating high population density with great civilization (e.g. China and Egypt) show that modern growth among these communities should be relatively fast (Chanda and Putterman 2007).

1.1.3 Economic Growth from a Historical Outlook

Economic growth is growth in GDP from a time period to another. It can be measured quarterly or yearly either in real or nominal terms. GDP estimates nation's total economic output and measures final production. GDP is composed of consumption, investment, government expenditure and net exports.

Smith (1954) pronounced that there exist natural coherences in economic life which stabilize the market i.e. power of the invisible hand. This was supported by Frederic Bastiat who argued that economic harmony in the world was created by God (Bastiat 1850). However, Pierre (1846) pointed out the economic contradictions that lead to destroying production or to the causing tensions in the process of production. The main concern is, what are the driving factors/ forces that regulate growth or development of the economy? Classical economists saw that economic growth is determined by improving capacity and investment. The neoclassical economists recognized land, capital and labor as key factors that influence economic growth. This proved to define the impetus of growth of economy in countries which are capitalist as increased use of factors led to improved economic growth. Robert Solow demonstrated that land, labor and capital had insignificant share in the US economy and showed that the main cause of economic growth was technological progress (Solow 1957). Nevertheless, Xavier Sala-I-Martin identified: physical capital accumulation, human capital, free capital movement, education, information, foreign investment, technology and diversity of institutions that favor the economy as key factors that drive economic growth (Salai-I-Martin 2001).Therefore divergence can be clearly seen considering the above views concerning the factors of economic growth.

During the era of mercantilism, the wealth of a nation was measured based on accumulation of bullion (mostly silver and gold) (Cameroon 2004). Mercantilists were followed by physiocrats who considered agriculture as the only sector that gave pure product. Physiocrats actions led to emergence of economic liberalism. Adam Smith and David Ricardo share the law of markets established by Baptiste Say to determine economic growth by production (Say 1960). Adam Smith argued that the size of the market will be affected by increase in production (Smith 1954). Karl Marx disapproved Say’s law of market but recognized the critical role supply plays in an economy. Malthus and Ricardo assumed decreasing returns to factors of production and were therefore regarded as pessimists (Czuma 2007). Karl Marx gave similar view as he observed that increased capital composition caused decline in rates of profit. Nevertheless, assumption of increasing productivity of factors of production by Adam Smith was not consistent with the rubrics of perfect competition which require that the level of price be the same as marginal cost.

According to Alfred Marshall, the existence of external economies gave rise to harmonization of increasing productivity of factors of production with perfect competition, Division of labour was viewed as the major determinant of economic growth by Adam Smith.While classical economists linked economic growth with supply, Keynes treated demand as most critical. The Great Crisis of 1929 disapproved the presence of any sovereign strength that assisted the economy in attaining a steady state as it brought a great economic failure. Keynes argued that capitalism has a natural tendency to imbalance and criticized as unrealistic the assumption that a steady state will be attained in an economy in the long-run. Keynes was persuaded by the unbalanced nature of economic growth and considered investments as his main factor driving economic growth. Keynes short run model did not factor passage of time but was later improved by Harod and Domar who dynamized the Keynesian model to capture a balance in the long run.

1.1.4 Changes in Population Density and Economic Growth in Kenya

Kenya's population and population density have been increasing over the years as shown in figures 1 and 2. The GDP growth was cyclical as shown in figure 3. In 1981, GDP growth rate was at 3.78 percent, declined to 1.31 percent in 1983 and rose to 7.18 percent in 1986. The worst performance was experienced in 1992 where Kenya had a negative growth of 0.799 percent. This could be attributed to introduction of multi-party politics in Kenya and the general elections of 1992. The economy recorded low growth rates of 0.35, 0.47, 0.60, 0.54, and 0.23 percent for years 1993, 1997, 2000, 2002 and 2008 respectively. The decline in 2008 was due to the 2007/2008 post-election crisis. The poor performance in 1991 to 1993 resulted from donors withholding their aid to the country which led to high inflation and low growth. Also there was shrink in agricultural production during this period. In 2010, the economy recorded the highest growth rate of 8.41 percent because of favorable weather condition and demand management policies that improved performance in the agricultural sector. However, the growth rate declined to 6.1 in 2011 and 4.56 in 2012. In 2017, the growth rate declined to 4.86 from 5.88 percent in 2016. In 2019, the growth rate declined to 5.37 from 6.32 percent in 2018.

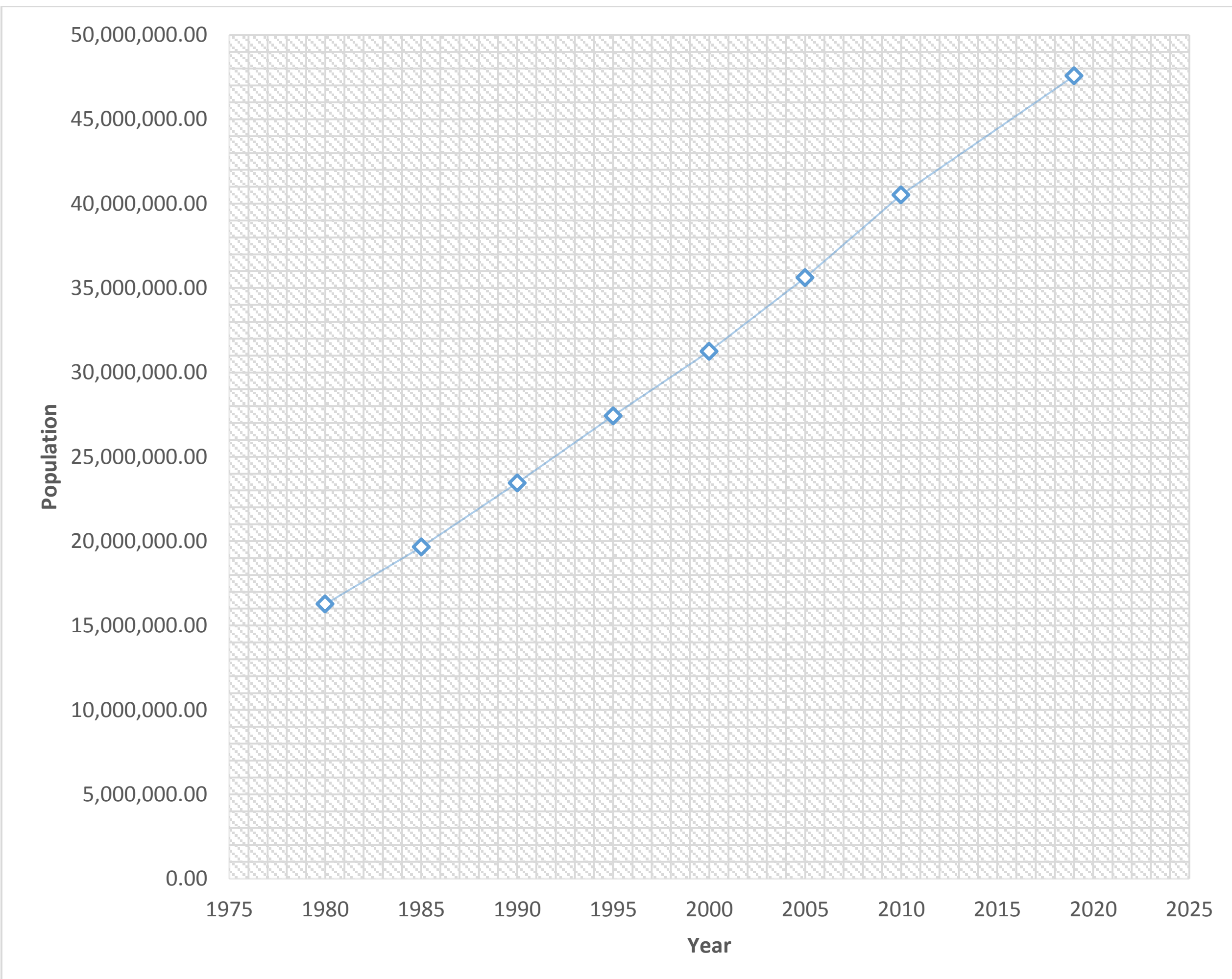


Figure 1: Trends in Population in Kenya

Source: World Bank Development Indicators Database

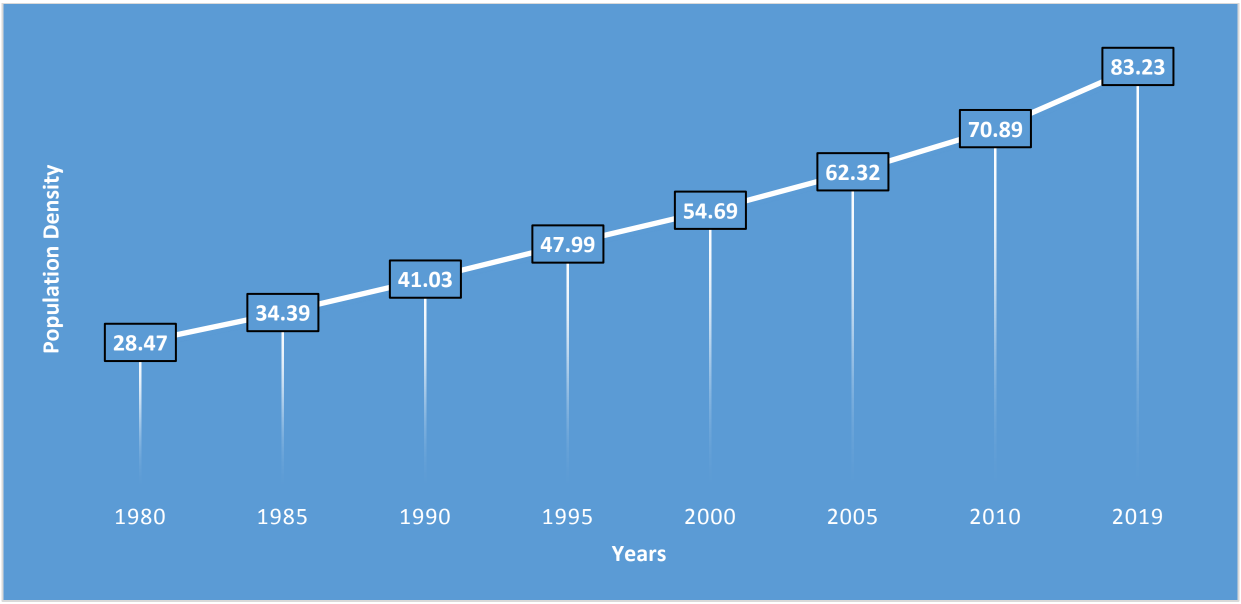


Figure 2: Trends in Population Density in Kenya

Source: World Bank Development Indicators Database

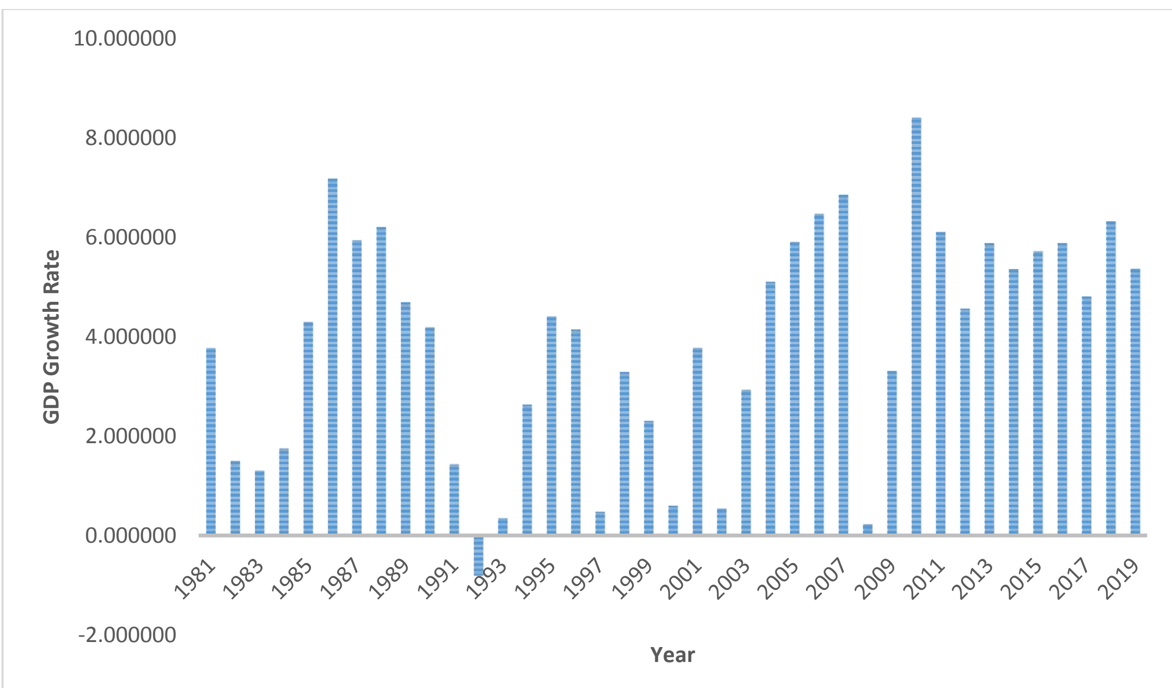


Figure 3: Trends in GDP Growth Rates in Kenya

Source: Computation by the author from World Bank Development Indicators Database.

1.1.5 Kenya Population Structure, Transition and Demographic Dividend

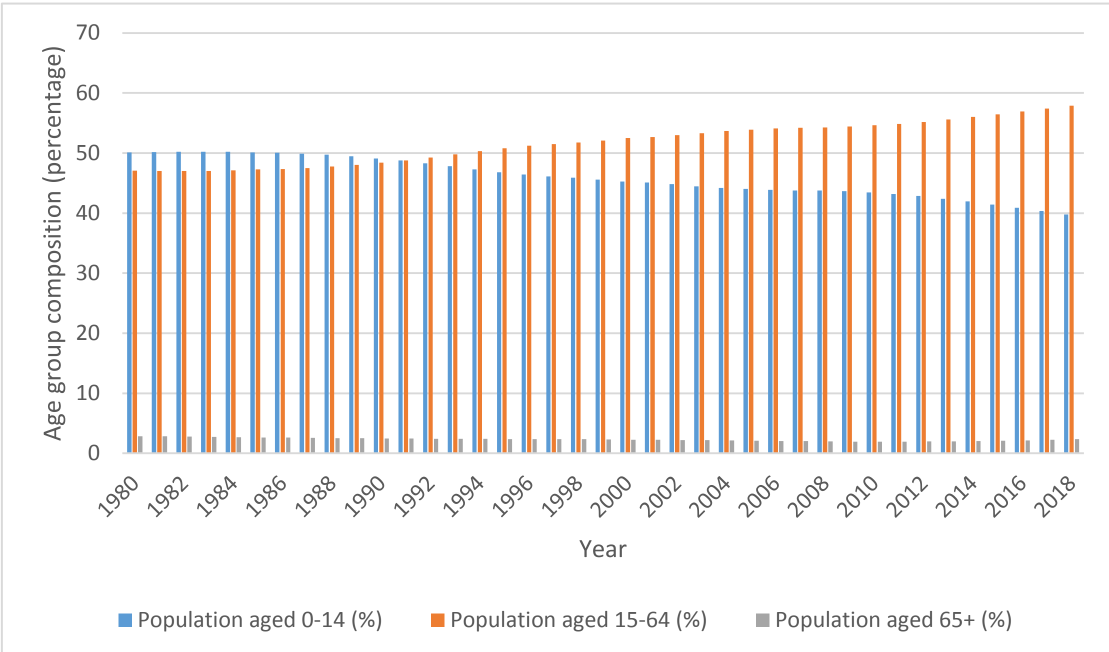


Figure 4: Trends in Age Composition (Percentage)

Source: World Bank Development Indicators Database

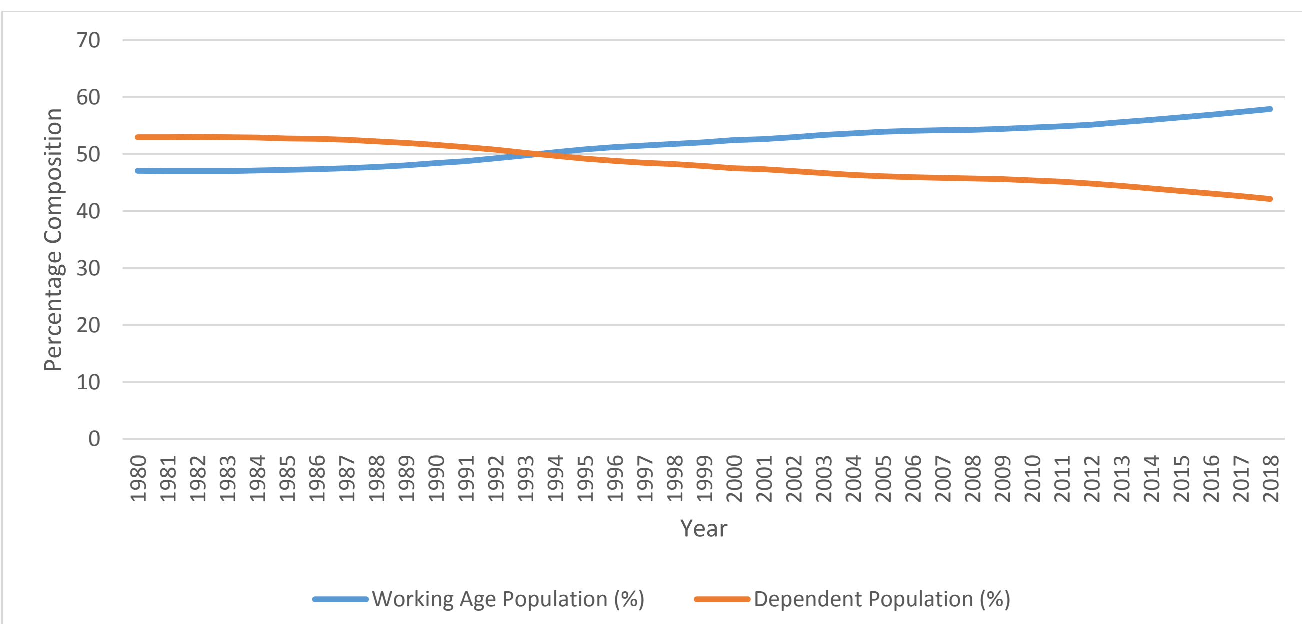


Figure 5: Trends in Working Age and Dependent Population Composition

Source: Computation by the author from World Bank Development Indicators Database

From 1994 onwards, the dependent population has been lower than the working age population as illustrated in figure 4. Republic of Kenya report (2014) documents that in 1960s, Kenya had fertility rates of 8 births per woman. The report also records that in 2013, these fertility rates had decreased to 4.4 births per woman. There was also a decrease in crude mortality rate from 20 per 1000 persons in 1960 to 8 per 1000 persons in 2013 resulting to improvement in life expectancy to 61.3 years in 2013 from 46.4 years in 1960. The percentage of the working age population in Kenya rose to 57.88 percent in 2018 from 49.23 percent in 1992 indicating that demographic transition has taken place setting the country towards realizing demographic dividend provided that other contributing factors are catered for.

According to Bloom and Canning (2008), increase in opportunities for economic growth due to reduction in the dependency ratio creates a demographic dividend. According to Bloom et al (2014), sound economic policies, education and integrated family planning are some of the factors that enhance gaining of demographic dividend for a nation. Therefore, to realize a demographic dividend, birth rates and death rates should decline followed by increased supply of labour (Bloom et al 2014). However, demographic dividend is not ensured by demographic transitions unless the productivity of the working age is enhanced by quality institutional environment. The broader measures for quality institutions include: infrastructure development and labour markets with laws and unions that protect employers and employees (Bloom et al 2007). Kenya has strengthened institutions since 2010 e.g. devolution of power and reforms in the police service, judiciary, public service and electoral system.

1.2 Statement of the Problem

Increase in population beyond normal limits in developing countries exerts pressure on basic social amenities which force governments to always overspend their budgets in provision of basic services. This may lead to high debts, reduced standards of living and budget deficits. Rapid population increase in the 1960s in developing countries was viewed as an impediment to social and economic progress. This was stressed on the Malthusian limits that increase in population densities will not be able to be supported by agriculture. Empirical investigations have not proved a strong correlation between population density and growth with statistical evidence.

Europe’s economic take off does not demonstrate that increase in population density always benefits, but it can be in particular circumstances. Countries like Vietnam and Nigeria are densely populated but with lower levels of economic development. Majority of emerging economies like Indonesia, India and China are highly densely populated and attract foreign direct investments because they have large market size.

Studies by Herzer et al in 2012 and Li et al in 2007 showed that population density significantly and negatively affects economic growth. This conformed to Malthusian argument in 1978 that population increase/growth was the major obstacle for economic growth. Nevertheless, a study by Williamson in 2001 found that population density affected economic growth positively depending on controls considered into a regression. Applying Malthus theory in 2011, Ashraf and Galor found that technological advancement before 1500 AD affected population density positively but did not affect living standards.

As a result of different observations among researchers on how changes in population density affect economic growth, these research questions arose:

a) What is the causal relationship between changes in population density and economic growth in Kenya?
b) Is the relationship between changes in population density and economic growth a short run or a long-run occurrence?
c) What are the effects of changes in dependent population and working age population on economic growth in Kenya?
d) What are the policy implications of the study findings?

1.3 Research Objectives

The main objective of this study is to examine how changes in population density affect economic growth in Kenya. The specific objectives are:

a) To investigate the causal relationship between changes in population density and economic growth in Kenya.
b) To investigate whether the relationship between changes in population density and economic growth is a short term or long run phenomenon.
c) To investigate the effects of changes in dependent population and working age population on economic growth in Kenya.
d) To draw policy implications of the study findings.

1.4 Significance of the Research Study

The study intends to inform and assist on policy regarding to demographic aspects and contribute additional literature on matters of population. The findings in this study will avail useful information and help government and policy makers on how to adopt structural reforms that can utilize population density as an instrument of economic growth. The study may also help investors to evaluate investment potentials in Kenya and NGOs and development partners to design programmes that fulfil societal needs. The study also seeks to compliment other studies made by other researchers and also create room for further research on the subject.

1.5 Scope and Limitations of the Study

The research deals with changes in population density and economic growth in Kenya for the period 1981-2017. However, this has not considered changes in population densities and growth in gross county products (GCPs) of counties in Kenya. Thus, there is a window for further research of the effects of changes in population densities in counties on their economic growths (growth in Gross County Products).

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The literature review focuses on both general and empirical studies carried out to examine the effect of population density changes on economic growth.

2.2 Theories on the Effect of Population Density

2.2.1 Uniformly Distributed Consumers and Firm Location

The first scholar to perhaps incorporate population density in economic writings was Harold Hotelling. With an interval [0, 1], Hoteling (1929) spread consumers uniformly on a beach in his model and permitted two companies to select price and location. He was later followed by Chamberlin (1933), Christaller and Loch (who were researchers from the regional science of 1930s). They all considered spatial rivalry of companies with some distributed buyers around and location. In their models, population density was typically constant but could be one or two dimensional. Its purpose was to stimulate demand based on spatial structure. This became the first role of population density in the economy. Models dealing with gathering spatially distributed natural resources consider not only land but also costs of transport. Transport costs are highly noticeable in nations which are lowly densely populated.

According to Yegorov (2009), a monopoly may not endure in lowly densely populated setting as it may not have the ability to compensate for consumers' transport costs or demand for consumers will be too low where it is located to cover fixed costs. Transport costs play a role that is different from other goods and therefore have to be accounted for carefully. In his paper, Yegorov (2005a) introduced the role of population density where he describes two dimensional Hotelling model and demonstrates demand continuity for a firm of defined population density. His paper presents a field concept originating from consumer's demand density which affects situation choice of a firm in heterogeneous space. With given fixed costs and demand density, some theorems about survival of monopolistic firms are formulated.

2.2.2 Effect of Population Density on the Economy

This model specializes on gathering resources that are distributed with an assumption of spatial collection of small farms (firms) utilizing Cobb-Douglas production technology. The model uses land, labour and a transportation system that collects and exports output at a linear distance. This model shows there exists an optimum population density that maximizes the profits of the exporting company (firm). In situation of a population density which is too low, there is a high endowment of resources per worker but too high transport costs and transport network maintenance cost. On the other hand, when population density is overly high, there are decreased profits because one worker uses too little land. An optimum population density exists for whichever specific economic activity concentrated on mining (extraction) of resources. Yegorov (2009) considered the possibility of a monopoly not surviving in a low densely populated area. A simple model was considered with a counteraction between economies of scale with increased transport costs for serving spatially bigger territory. The significant thing considered is that density of a population affects cooperative and non-cooperative behavior. Usually, big projects require cooperation while in small projects non-cooperative behavior (and the risk of cheating) occurs. Small population density is believed to be more favorable for collaboration. Yegorov (2014) introduces coexistence model between rural (doing farming) and urban (doing manufacturing) regions with migration possibilities. The emphasis is on the effect of shocks in prices on food (or energy) in allocating the population in space to such equilibrium. The model is further adapted for Russia's situation.

2.2.3 An Optimal Country Size

Yegorov (2005b) tackles the issue of optimal size of a country. Both resource density (A) and population density influence per capita resource endowment. A country with uniform population density is believed to have a square shape (taken as size a). In this model, there are two principal costs. The first is border protection cost which are linear to the spatial variable a. The other (second) cost relates to the population and center. Therefore, this nation's expense is symmetrical to population density and the parameter of a cubed. And the nation's surplus is:

$$\Pi = Aa^2 - 4a - ct\rho a^3 \quad (1)$$

Where A is density of a resource, t is cost of distance transport per unit and c is a constant that accounts for the number of journeys made to the capital. The boundary with the nation is the $4a$ and cost of defending a unit of boundary distance is standardized to one. For a dictatorship this represents the overall surplus for the country whereas for a democracy it is surplus per capita, indicated by $\pi = \Pi / N$. The total population is given by $N = \rho a^2$. The optimum spatial scale for a democracy is:

$$a^* = 2(ct\rho)^{-1/2} \quad (2)$$

The two have negative partial derivatives.

$$\partial a^*/\partial \rho = -(ct)^{-1/2}\rho^{-3/2} < 0, \text{ and } \partial a^*/\partial_t = -(c_P)^{-1/2}t^{-3/2} < 0 \quad (3)$$

This shows that as transport costs increase, optimum country size becomes smaller. The need for higher travel costs would offset the advantages of economies of scale in protection of the border. The resource density A has no role at this point since per capita resource endowment doesn't depend on size of the country. Remarkably, according to the model's assumptions, all democracies have similar total population $N = \rho a^2$ but they can vary in population density. In the case of dictatorship consider model (1). Differentiating formally with respect to scale variable a offers optimum size:

$$a^{**} = \left[A + (A^{-2} - 12ct\rho)^{1/2}\right]/(3ct\rho) \tag{4}$$

Partial derivatives can now be considered. The optimum country size reduces where transport costs rise:

$$\partial a^{**}/\partial t = -\{A+[A^2-12ct\rho]^{1/2}\}/[3ct^2]-2/t[A2-12ct\rho]1/2>0, \tag{5}$$

Since transport costs and population density symmetrically enter equation (4), the resultant partial derivative is also negative i.e. $\partial a^{**}/\ \partial \rho < 0$. On the other hand, there is a positive partial derivative w.r.t. resource density:

$$\partial a^{**} / \partial A = \{1+ [1-12B]^{-1/2}\}/ [3ct\rho]>0, \ B \equiv ct\rho \ / \ A^2, \tag{6}$$

Optimum population denoted as N* can be computed:

$$N^*=\{1+[1-12B]^{1/2}\}2B/(9ct)-3/(3ct) \tag{7}$$

In the case of small B, the partial derivative $\partial N/\partial B > 0$. Considering fixed population density and costs of transport, higher B implies lower per capita resource density A. Therefore, a dictator will optimally try to enlarge the size of the nation even in population terms if extra territories are having lower per capita resource endowment. For example, Canada and Australia have lower population and resource density compared with United Kingdom within the British Empire. This also remains factual about Russian expansion to Siberia during 16th century and American expansion to the west during 19th century. Advances in technology led to reduced transport costs, resulting to expansion.

2.2.4 Hotelling Type Model with two types of Goods (two producers) and Dispersed Consumers

The objective of this model is to disclose how distance between two producers and a consumer affect their substitution between the two goods consumed and how the population density determines profits of those producers. Consumers mostly prefer to visit the nearer place more. Take a set of several customers indicated by $0<q<1$ and evenly distributed over the interval {0, 1} as in Hotelling's model (1929). Assume that consumers demand for two products which are produced at boundary points: product X in q=0 and product Y in q=1. Assume the consumers have similar income standardized to one and Cobb-Douglas expectations with a=1/2 for products X and Y:

$$U(q) = X^{1/2}(q)\, Y^{1/2}(q). \tag{8}$$

The motive for producing goods at these points could be economies of scale. However, someone might imagine about controlled monopoly producing at the level of cost or being permitted for a fixed profit rate. The full price also includes cost of transport of every consumer to the market. Take ץ as the cost of transport for each unit of distance. Therefore, the consumer's budget constraint can be presented as:

$$(1+ ץq)\, X(q) + (1+ץ - ץq)\, Y(q) = 1. \tag{9}$$

Considering Cobb-Douglas optimization, the consumer spends equally for both goods. Therefore:

$$(1+ ץq)\, X(q) = (1+ץ - ץq)\, Y(q).$$

Consumer q will choose:

$$X(q) = [2(1+ץ q)]^{-1}, \quad Y(q) = [2(1+ ץ (1-q))]^{-1} \tag{10}$$

Performing integration, the total demand for good X is obtained.

$$D(X) = \ln(1+\tau)/2\tau. \quad (11)$$

Taking ρ as the population density over unit interval, this demand is multiplied by the corresponding factor. The effects are that low density of population reduces the entire market for good X and the rise in cost of transport lowers general demand. Normally, competition with other firms determines the output of a firm with price p and cost F. If all market is captured, its maximum profit is given by:

$$\Pi = p\rho \mathrm{In}(1+\tau)/2\tau - F \quad (12)$$

A monopolist can become bankrupt if population density reaches a minimum reasonable value or the costs of transport exceed some maximum acceptable value. This case illustrates that a firm has to compete both with competing firms and low demand conditions. For a certain service to be provided, some minimum population is necessary. That is the reason some places may not have some type of services (such as theatre, hospital etc.) and this contributes to the disutility to stay in those places. Rural villages can also be depopulated because no one funds their roads. Some nations have specific state initiatives to develop this type of infrastructure.

2.3 Economic Growth Theories and Models

According to Joseph Schumpeter, economic development was determined by the creativity and innovation of entrepreneurs. As innovation is introduced, an entrepreneur makes huge profits, but with time, competitiveness duplicates the invention forcing profits to reduce. Schumpeter bases his theory on the assumptions of competitive market, private property and financial market efficiency that encourages new innovations. His theory is commonly applied to democratic and economically developed countries.

In his theory, Arthur Lewis tackled the problem associated with poor countries which have abundant labour force (Lewis 1954). In his model, Lewis assumes a low standard of living should be maintained in the short run so that the savings got will increase the capital stock and trigger long run income growth. However, Lewis' theory has some limitations in that the issue of poverty cannot be deferred until an unstipulated future. This would mostly affect the poor people as increased capital accumulation is achieved by decreasing consumption.

Walt Rostow introduced a new theory of economic growth making economic development rely on his famous five development stages and on accumulation of capital (Rostow 1960). Rostow observed that poor countries have a major problem attaining the "take off" stage. Nevertheless, Rostow realized that there was need for external support in cases where there were no opportunities to increase internal accumulation. Rostow noted that rebuilding of the economy from farming to industrialization would spur economic growth across the entire country.

Growth is sustainable under the Harrod-Domar model if guaranteed growth rate, natural growth rate and actual growth rate are all equal. Harrod termed such a condition as the golden era where attained macroeconomic equilibrium guarantees optimal use of capital and labour. But equilibrium requires equal savings which depend on investments by capitalists and households. Savings rate and population growth are exogenous. Moreover, the model assumes a constant capital to labour ratio ensuring there is no possibility of substituting factors of production. Therefore, the three growth rates do not have a mechanism for harmonizing them.

In the Kalecki model, investments but not the level of savings realized are key determinants in growth process. That is the why Kalecki's model is referred to as investment because he observes that investment determines long-term economic growth (Kaleckie 1956).

Robert Solow and Trevor Swan suggested similar models of long term economic growth in their reaction to the non-satisfactory results obtained from Harrod-Domar model. The Solow-Swan model showed that sustainable growth was achieved by an economy where per capita income and population growth rates were equal. Therefore, the Solow-Swan model solved the two problems of economic uncertainty and the impossibility of maximum usage of labour as identified in Harrod-Domar model.

Hirofumi Uzawa, a Japanese economist developed an economic model consisting of two sectors in the early 1960s (Uzawa 1963). Consumer goods are produced in the first sector while capital goods are produced in the second sector. It is a stable model when the capital/labour ratio is higher in the consumer goods branch than in the capital goods generating branches.

Frank Ramsey developed a model where the savings rate relies on the choices of consumers and is endogenous. The findings regarding steady state growth rate in Ramsey-Cass-Koopmans model are similar to those obtained using Solow-Swan model.

Diamond incorporated analysis of the finite horizon into another neoclassical model. Household's life is broken down into two periods. Households are receiving wages and salaries in the first period and spend them on savings and current consumption. Households do not earn in the second period but their present consumption is funded from the first period through accumulated savings. In the long run, the economy attains a stable state (Diamond 1965).

Kenneth Arrow and Marvin Frankel developed the first endogenous growth model. Frankel argued that the neoclassical production function relates to individual firms but macro economy grows consistently with the AK. This is anchored on the assumption of introduction of the factor of externalities to the production function that reveals the extent of country's economic progress (Frankel 1962). Kenneth Arrow disagreed with the findings obtained from neoclassical models and assumed that knowledge is obtained due to a process known as "learning by doing"(Arrow 1962). The argument by Kenneth Arrow on long term growth does not make it reliant on savings despite using production having increasing returns to scale (Arrow 1962). Schultz observed investments in human capital include the costs of professional development, health and education (Schultz 1961).

In his presentation of his endogenous growth model, Paul Romer considered capital externalities into the neoclassical production function. In his model, there exists endogenous growth as production function experiences constant returns to scale but production factors exhibit increasing returns to scale. In order for the economy to grow in accordance to the AK production function, certain conditions must be fulfilled which are: significant size of externalities and existence of scale effect (Romer 1986).

Robert Lucas suggested an endogenous growth model with two sectors. Lucas argued that physical capital is used in the production process and human capital influences productivity growth of both physical capital and labour. Therefore nations endowed with human capital grow faster than nations having limited human capital resources.

In the Aghion-Howitt model, technological improvement is observed in the improved quality of goods prevailing in the market. A country which possesses more human capital resources of more educated persons will have a faster growth compared to a country with low levels of human capital (Aghion, Howitt 1992). Becker, Murphy and Tamura determined correlations between population growth and investments in human capital. They concluded that nations with low levels of human capital tend to have big families (Becker, Murphy, Tamura, 1990).

2.4 Empirical Literature

Alfred Marshall (1890) introduced the concept of agglomeration economies. These are economies that firms experience as a result of closely clustering together due to presence of knowledge spillovers, adequate supply of raw materials and availability of highly skilled workforce among others. Population agglomeration usually contributes to agglomeration of economic activities, division of labour and higher job specialization.

Becker et al (1999) viewed that in modern urban economies, the increased density as a result of larger population encourages bigger investment in human capital and specialization. This specialization contributes to increased returns in resource constrained economies that offsets diminished labour returns. Increased rivalry leads to further technical advancement. The resultant situation is a cycle in the entire population that accesses higher living standards, while a greater proportion of that population moves to urban areas. Economists warn that countries with extremely low human resources and basic technologies do not benefit from higher density of population. This suggests that these nations have to pass a certain threshold.

Ciccone and Hall (1996) saw increased density returns in the United States industrial structure during the 1960-1990s with the productivity of labour also rising upon considering dilution of capital.

There are more population density studies which were done by Brulhart and Shergani (2008), Hussain and Hayat (2009) and Nica and Grayson (2008). These studies were empirical and found that population density affected productivity positively. Needless to say, the most recent of their studies applying cross-section OLS estimates for 105 nations in the 1960-2000 period discover that urbanization is not beneficial to rich nations. The beneficial agglomeration effect is reversed at a per capita GDP of about US $10,000 (based on 2006 prices) which totally contradicts Becker's theory conclusions.

A study by Klassen and Nestman (2006) used population density and empirically tested it in the period 0-1500 AD. Their conclusion was that absence of population density prevents less developed nations from getting human capital which would permit them to pass the development threshold, specifically referring to African countries.

According to Lucas (2007) agricultural economies are likely to be less productive, suggesting that industrialization is crucial for growth and is usually correlated with urbanization and urban clustering. An analysis of the Western Europe from 1850 to 1990 conducted by Malmberg and

Lindh (2002) found that higher density contributed to industrialization, capping off with the Lucas model.

Boucekkine, Croix and Peters (2007) argued that population density triggers prosperity. Using counterfactual experiments during the 16th and 17th centuries for England, they discovered that 33 percent of the increase in literacy can be attributed population density (because education institutions were established).

Kelly and Schmidt (1995) concluded that population density and size influence economic growth transitionally. Other studies have indicated that the change in the pattern of age distribution affected economic growth substantially through savings and investment (Bloom and Williamson, 1997). According to Bloom and Canning, a robust evidence exists that demographic change impacts significantly on the process of economic growth e.g. rise in life expectancy tends to increase education and investment thereby increasing human and physical capital investment (Bloom and Canning, 1999)

Bloom, Canning and Malaney (1999) explored the connection between demographic change and economic growth for the period 1965-1990. To achieve their goal they collected data from all world regions for 70 countries and covered the period 1965-1990. The findings suggested that both the economic failure of South Asia and economic success of East Asia were largely due to demographic factors particularly disparities in health status, dependency ratio and concentration of people.

The demographic change of East Asia was among the crucial factors behind the fantastic economic growth of the region according to Bloom, Canning and Sevilla (2001). Between 1965 and 1990, per capita income increased by more than 6 percent annually. With the advantages of the liberalized economy and good education, the younger people were recruited into the labour market thereby growing the potential of the region for economic growth. During the same period, the working age population grew faster compared with dependent population. Consequently, this favorable demographic change increased income growth which had the effect of pushing down population growth. Furthermore, the demographic transition also affected the high saving rates in East Asia because baby boom generation began entering the workforce.

Bloom and Canning (2001) addressed three various ways by which demographics can affect economic growth: (a) effect on labour market (b) effect on savings and accumulation of capital and (c) effect on enrolment in education and human capital. Effects on the labour market could be established by examining dependency rates which reveal significant effects on the age structure. Effects on capital accumulation and savings are based on assuming imperfect global capital markets, meaning that national investments are roughly equal to national savings. Due to improved rates of return on education, high youth dependence ratios can hinder high school enrolment rates when concerns affect education enrolment and human capital. As argued by the authors, lowering death rate may increase the proportion of labour force, increase in educational returns and generate higher savings. Later, a bigger percentage of old age dependents may raise their productivity through higher intensity of resources. Furthermore they claim that besides age structure, the density of a population may affect economic growth.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter entails the theoretical model, philosophical orientation of the study, research strategy and design of the research. It also captures data sources, data collection, data sample and data analysis. The empirical model adopted for the study is also presented.

3.2 Theoretical Model

According to Kremer's framework change in technology depends absolutely on population. It also depends on income and technology levels. It is argued that it's reasonable to assume that changes in technology depend also on population density because it eases communication, exchange and expands market size. Population density enhances specialization and generates the necessary demand for innovation which stimulates development and flow of new technologies (Becker et al 1999). Generally, Kremer's model is extended by including population density.

3.3 Model Specification

The simple version by Kremer is founded on two important assumptions

i. The model assumes technology as a public good making it non-rival and as Romer (1990) pointed out, non-excludable. Kremer assumes also that the research productivity of each person does not depend of size of the population. This implies that there is a bigger number of inventors in larger populations. Larger populations show higher technological growth rates when combined with the public good nature of technology.

ii. Technological progress (state of food production) limits population growth rate.

Output (Y) is produced using a Cobb-Douglas production technology where inputs used are population (P) and Land (T). Output level depends also on existing level of technology.

$$Y=AP^{\alpha}T^{1-\alpha} \tag{1}$$

Output per capita (y) is obtained after standardizing T to one followed by division of both sides by P:

$$y = AP^{\alpha-1} \tag{2}$$

Here Kremer assumes that population adjusts to economic circumstances immediately. Income per capita can thus be indicated by $\bar{y}$.

Solving equation (2), an equilibrium level of population size (P) is obtained as:

$$P = \left(\frac{\bar{y}}{A}\right)^{\frac{1}{\alpha-1}} \tag{3}$$

The opportunity to invent a new thing depends on population size. Additionally, each individual is assumed to have similar research productivity. Technological growth rate is determined by population level:

$$\frac{\dot{A}}{A} = P * g \tag{4}$$

$\dot{A}/A$ represents the rate of growth of technology while g represents research productivity per capita.

Assuming per capita level is constant, logarithms in equation (3) give rise to:

$$\ln P = \frac{1}{1-\alpha}(\ln y - \ln A) \tag{5}$$

Differentiating this term w.r.t time we obtain the growth rates leading to equation (6):

$$\frac{\dot{P}}{P} = \{\frac{1}{1-\alpha}\} \times \frac{\dot{A}}{A} \tag{6}$$

$\left(\frac{\dot{A}}{A}\right)$ is substituted from equation (4) in equation (6) to show how population growth rate relates to population size in (7)

$$\frac{\dot{P}}{P} = \frac{g}{1-\alpha} P \tag{7}$$

Otherwise, at some level, productivity of research can also decrease with size of the population due redundant research activities. As a result, the more general equation of technological change becomes:

$$\frac{\dot{A}}{A} = gP^{\psi}A^{\phi-1} \tag{8}$$

Population therefore grows as defined by equation:

$$\frac{\dot{P}}{P} = \frac{y}{1-\alpha} P^{\psi+(1-a)(\phi-1)} \times y^{(\phi-1)} \tag{9}$$

With this extension, Kremer describes better intellectual exchange, specialization and urban development as outcomes of population density that are not absolutely linked to population size.

3.4 Influence of Population Density on Technological Change

Population density may also influence endogenous technological change process shown by equation (8). In the production function, the land variable T in this version is not standardized to one. From equation (1), the production function becomes:

$$Y = AP^{\alpha}T^{1-\alpha} \tag{10}$$

By dividing equation (10) by P, we obtain production function per capita (11) which is dependent on population density.

$$y = A\left(\frac{P}{T}\right)^{\alpha-1} \qquad (11)$$

This indicates that marginal productivity per person declines as more persons work on a fixed area of land and vice versa. Kremer's model assumes that there is immediate adjustment of population to economic circumstances. Hence, equilibrium population density is shown as:

$$\frac{P}{T} = \left(\frac{\bar{y}}{A}\right)^{\frac{1}{\alpha-1}} \qquad (12)$$

Technological growth rate depends on population density, research productivity per capita, population size and the level of technology in this current version of the model. P is multiplied by individual research productivity to calculate the total research output in an economy.

Relating this theoretical model to the study, an extract from equation (11) can be expressed as:

$$GDPGR_t = f(PDGRt, HCIGRt, GCFGRt) \qquad (13)$$

and

$$GDPGR_t = f(WAGRt,\ DEDPGRt) \qquad (14)$$

Where:

$GDPGR_t$ is the Gross Domestic Product Growth Rate at given time t

$PDGR_t$ is Population Density Growth Rate at given time t

$HCIGR_t$ is the per capita Human Capital Index Growth Rate at given time t

$GCFGR_t$ is the Gross Capital Formation Growth Rate at given time t

$WAGR_t$ is the Working Age Population Growth Rate at given time t

$DEPGR_t$ *is* the Dependent Population Growth Rate at given time t

3.5 Philosophical Orientation of the Study

The study assumed positivism research philosophy which complies with the view that only factual information obtained through observations including measurements is trustworthy and the researcher's role is restricted to the gathering, analysis and interpretation of data through objective approach. The findings of the research are generally observable and quantifiable. In positivism, statistical analyses are done from observations that are quantifiable. In addition, the research is independent from the study and there are no human interests' provisions in the study (Crowther and Lancaster 2008).

3.5.1 Research Approach

Understanding available research approaches is a significant step in any research work. These research approaches can either be deductive or inductive. In deductive approach, the research problem is solved by reviewing existing theories where hypotheses are subsequently tested based on empirical results. Additionally, relevant theories can be reviewed by either confirmation or rejection of hypotheses which are stated at the start of the research (Bryman & Bell 2007). This study used a deductive research approach.

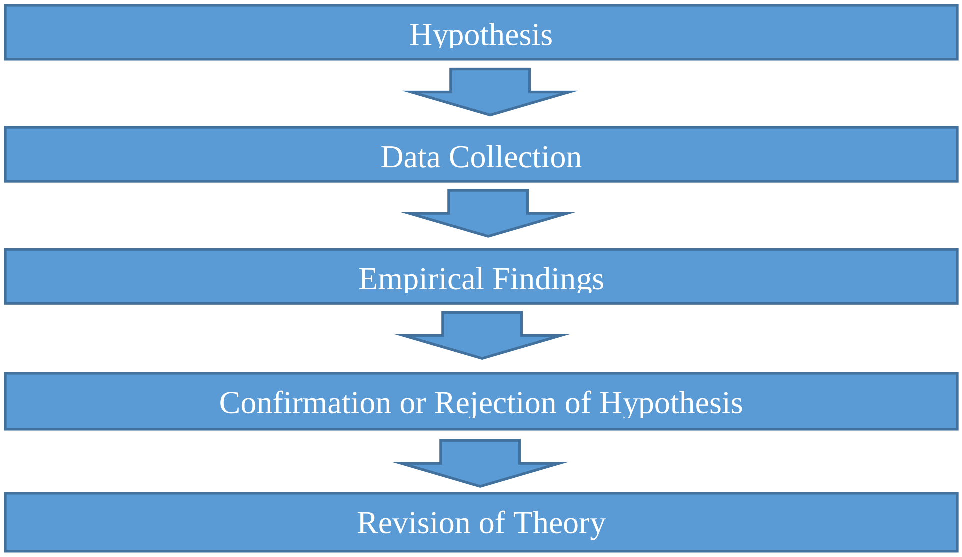


Figure 6: The Process of Deduction

Source: Bryman and Bell 2007

3.5.2 Ontological Considerations

Social ontology issues pertain to the existence of social units. The main point of orientation here is whether social units should be viewed as either objective units with a reality external to social actors or social constructions based on social actor's perceptions and actions (Bryman and Bell 2007).

In this study the ontological consideration is objectivism. The study estimates effects on economic growth from changes in population density, working age and dependent population. Therefore, the questions of the scientific research are in view of objectivism.

3.5.3 Epistemological Considerations

An epistemological concern is the issue of how to examine a social reality. The main issue in this scenario is whether or not the social world should be examined in line with the same principles, ethos and processes as the natural sciences (Bryman and Bell 2007). As far as positivism is concerned, reality exists objectively out there and knowledge about it can be obtained by only following scientific methods where hypotheses are tested. It is only in quantitative design where the researcher attempts to be neutral to the study's object. Time series data is gathered from 1981 to 2017 and positivism paradigm is applied to resolve the problem statement.

3.6 Research Strategy

Research strategy considers the objectives of the study, data access and constraints that may affect the research process. Quantitative research emphasizes on quantification in data gathering and analysis and includes a deductive approach to the connection between theory and research where emphasis is put on testing theories (Bryman & Bell, 2007). This paper pursues quantitative strategy as it uses numerical data.

3.7 Research Design

A research design offers a structure for collecting and analyzing data. Decisions concerning precedence set to a variety of dimensions of a research process are reflected by the choice of a research design. These entail the importance connected with: articulation of causal relationships between variables; generalizations to bigger groups of individuals than those which form part of the study; understanding behavior and how it means in its particular social setting and having a chronological appreciation of social occurrences and their interconnections.

This paper uses longitudinal design and focusses on examining effects of population density on economic growth in Kenya based on time series data, which limits the study within Kenya. Longitudinal design is used to record societal change and the causal impacts over a period of time. Observing individuals or events over a period of time wield a degree of control over the variables under study ensuring that the research process does not affect them (Saunders et al., 2009).

3.8 Data

3.8.1 Data Sources and Collection

There are two data sources in this study. Secondary data for economic growth, gross capital formation, working age and dependent population were obtained from World Bank Development Indicators Database. Secondary data for human capital per capita was obtained from Penn World Table 9.1.

The choice of secondary data was necessitated by various reasons. Secondary data is more convenient to use and saves time and research cost. It is also credible since it is based on previous studies or primary data. Nevertheless, there are some disadvantages of using secondary resources. The most serious problem is that the quality of the secondary data may be affected as the researchers do not participate in the planning and implementation of previous process of collection of data.

Even if secondary data is imperfect, this study employs it as the main resource in conducting the whole research. On the other hand, secondary data is also credible and can be of high quality if it is used carefully by taking into account the effect factors.

3.8.2 Data Sample

The ARDL approach offers robust results for cointegration analysis on smaller samples. Tang and Niar (2002) employed ARDL bounds test using 28 observations while Pattichis (1999) and Mah (2000) studies applied 20 and 18 observations respectively. Moreover, according to Alam and Quazi (2003), the ARDL bounds procedure is possible even when the explanatory variables are endogenous. Narayan (2004) formulated two sets of suitable critical values for a sample size study ranging from 30 to 80 observations. One set assumes that all variables are I (1) and another assumes all variables are I (0) or even fractionally integrated. Since the study's sample size is 37, this gives encouragement to embrace the ARDL model.

A non-probability sampling method was used in picking the appropriate sample for the study in which subjects are chosen on a basis other than random selection. The type of convenience sampling used in this study was consecutive sampling where each consecutive eligible observation was considered for selection for the period 1981 to 2017. Consecutive sampling gives some structure and thus more rigor in that it contains all observations which are available within the given study time period. It is more likely that the resulting sample will represent the target population.

3.8.3 Data Analysis

Unit root analysis and selection of lag lengths were done using Stata statistical software. Bounds test approaches, long run and short run analysis and post estimation diagnostic tests were done using Microfit 5.50 statistical software.

3.9 Pre-diagnostics Tests

3.9.1 Stationarity

Time series process is stationary if its probability distributions are stable overtime. Stationary check is required to make sure that the dataset has both constant mean and variance. Augmented Dickey Fuller test was used to check for stationarity. This test was done to check non-stationarity problem that would give findings that are spurious (nonsensical). Additionally, stationary test was done to ascertain that no variable has an integration of order 2 or more.

3.10 Empirical Methodology

The study employed ARDL bounds testing procedure initiated by Perasan and Shin (1999) and further advanced by Perasan et al (2001). ARDL has the capacity to host sufficient lags that enable data generation process mechanism to be better recorded. ARDL approach can be applied where time series is at stationary level, first difference stationary or both. However, the time series should not be integrated of order 2 or more within the ARDL framework as this order of integration invalidates all critical values and Perasan's F-statistics.

ARDL approach produces unbiased estimates and valid t-statistics. Due to the appropriate selection of lags, residual correlations are removed. The error correction mechanism (ECM) can integrate short term adjustments with the long term equilibrium. ARDL method also permits for the outliers that have impulse dummies to be corrected. Lastly, it is fairly straight forward to interpret and implement the ARDL approach. It is also more reliable compared with the method of cointegration used by Johansen and Juselius (Haug 2002).

The ARDL bounds test includes the F-test to verify that there is level relationship among variables. The null hypothesis of no level relationship (i.e. no cointegration) among the variables (H_0:β_1=β_2=β_3=0) is tested based on Perasan et al (2001) against existence of a level relationship ((H_a: $\beta_1 \neq \beta_2 \neq \beta_3 \neq 0$). The decision criterion is based on the following:

Result	**Decision**	**Conclusion**
F-Statistic (value) > UCB	Reject the null hypothesis	There is cointegration
F-Statistic (value) < LCB	Fail to reject the null hypothesis	There is no cointegration
LCB < F-Statistic (value) < UCB	Inconclusive	Inconclusive

3.11 Empirical Models

3.11.1 The Role of Population Density on Economic Growth

The main objective of the study is to investigate whether changes in population density affect economic growth. This relationship is given in form of linear empirical model that is specified as:

$$GDPGR=\alpha_0+ \alpha_1 PDGR + \alpha_2 HCIGR + \alpha_3 GCFGR + \varepsilon_t \qquad (1)$$

In performing bounds test for cointegration, an ARDL model with four variables is specified:

$$\Delta GDPGR_t = a_{01} + a_{1i}\Delta GDPGR_{t-i} + \Sigma a_{2i}\Delta PDGR_{t-i} + \Sigma_{a3i}\Delta HCIGR_{t-i} + \Sigma a_{4i} GCFGR_{t-i}$$

$$+b_{11}GDPGR_{t-1}+b_{21}PDGR_{t-1}+b_{31}HCIGR_{t-1}+b_{41}GCFGR_{t-1}+e_{1t} \qquad (2)$$

Where:

GDPGR -is the annual growth rate of gross domestic product (a proxy for economic growth);

PDGR annual growth rate of population density (a proxy for changes in population density)

HCIGR -is the annual growth rate of index of human capital index per person (a proxy for changes in human capital)

GCFGR -is the gross capital formation growth rate(a proxy for changes in investment)

a_{01} -is the intercept

a_{1i}-a_{4i} -are short-run slope coefficients

b_{11}-b_{41} -are long-run slope coefficients

e_t -is the error term

Δ -is the difference operator

The error correction model of the ARDL (1) is expressed as follows:

$$\Delta GDPGR=a_{01}+\Sigma a_{1i}\,\Delta GDPGR_{t-i}+\Sigma a_{2i}\,\Delta PDGR_{t-i}+\Sigma a_{3i}\,\Delta HCIGR_{t-i}+$$

$$\Sigma a_{4i}\Delta GCFGR_{t-i}+\lambda ECM_{t-1}+e_t \qquad (3)$$

Where:

λ - is the ECM coefficient

ECM_{t-1} -is the error correction term lagged by one period

3.11.2 The Role of Working age Population and Dependent Population on Economic Growth

The assessment of the effect of age composition of the population has significant policy implications as it gives an overview in tracking shifts in a country's population. The relation of working age and dependent population on economic growth can be specified as:

$$GDPGR=\alpha_0 + \alpha_1 WAGR + \alpha_2 DEPGR + \varepsilon_t \qquad (4)$$

The ARDL model can be specified as follows:

$$\Delta GDPGR = \alpha_0 + \Sigma\, \alpha_{1i}\Delta GDPGR_{t-i} + \Sigma\, \alpha_{2i} WAGR_{t-i} + \Sigma\, \alpha_{3i} DEPGR_{t-i}$$

$$+\beta_1 GDPGR_{t-1} + \beta_2 WAGR_{t-1} + \beta_3 DEPGR_{t-1} + \mu_t \qquad (5)$$

Where:

GDPGR	-is the annual growth rate of gross domestic product (a proxy for economic growth)
WAGR	-is the working age growth rate (a proxy for working age population)
DEPGR	-is the dependent population growth rate (a proxy for dependent population)
α_0	- is the intercept
α_{1i}- α_{3i}	- are short run slope coefficients
β_1-β_3	- are long run slope coefficients

The related error correction model is specified as:

$$\Delta GDPGR = \alpha_0 + \Sigma\, \alpha_{1i}\Delta GDPGR_{t-i} + \Sigma\, \alpha_{2i} WAGR_{t-i} + \Sigma\, \alpha_{3i} DEPGR_{t-I} + \lambda ECM_{t-1} + \varepsilon_{1t} \qquad (6)$$

Where:

ECM_{t-1} - is one period lagged error correction term

λ - is the coefficient (adjustment speed) of ECM.

3.12 Stability Test and Post Estimation Diagnostic Tests

CUSUM and CUSUMSQ plots were used to test for stability of the estimated ECM and ARDL model. Additionally, heteroscedasticity, normality, functionality and serial correlation diagnostic tests were done for residuals.

CHAPTER FOUR

EMPIRICAL FINDINGS

4.1 Introduction

This chapter reflects on analysis and presentation of data in line with the study objectives. It shows the findings of this study.

4.2 Unit Root Tests

Before applying ARDL approach, it was necessary to test for stationarity condition of all variables to find out their order of integration. This is to make sure that the variables are not I (2) stationary or beyond so as to avoid results that are spurious (non-sensical). The ARDL approach is valid if the series are stationary at I (0) or I (1) or I (0) I (1). Using ADF, the unit root results shown in table 1 below disclose that the variables used are all stationary in levels or first differences. This therefore validates the suitability of using ARDL bounds testing approach to work out on cointegration and ARDL regression analysis.

Table 1: Stationarity Tests of Variables using ADF

	Stationarity of all variables in levels		Stationarity of all variables in first differences	
Variable	Without trend	With trend	Without trend	With trend
GDPGR	-3.338**	-3.585**	-	-
PDGR	-3.160**	-8.464*	-	-
HCIGR	-0.528	-3.396***	-4.435*	-4.363*
GCFGR	-3.958*	-3.938*	-	-
WAGR	-0.996	-2.047	-3.870*	-3.805**
DEPGR	-1.547	-1.897	-3.229**	-3.221***

*Note: *, ** and *** denote stationarity at 1%, 5% and 10% level respectively.*

Source: Data generated using Stata 14.

4.3 Cointegration Test

Both models 1 and 2 show presence of cointegration as their calculated F-statistics are bigger than the critical values from Perasan et al (2001) as shown in table 2 below.

Table 2: ARDL Approach to Cointegration Results

Dependent Variable	Function	F-Statistic	Lower Bound		Upper Bound		Outcome
			95%	90%	95%	90%	
GDPGR	F(GDPGR|PDGR,HCIGR,GCFGR)	7.6010*	3.5619	2.9480	4.8633	4.0863	Cointegrated
GDPGR	F(GDPGR|WAGR,DEPGR)	4.7790**	4.1374	3.3536	5.3724	4.4391	Cointegrated

*Note: * and ** denote cointegration at 5% and 10% respectively.*

Source: Data generated using Microfit 5.50

Optimal lag lengths for models 1 and 2 were selected based on either Schwarz Bayesian Criterion (SBC) or Akaike Information Criterion (AIC) which depended on the most parsimonious model. Based on table 3 below, the optimal lag lengths were 2 and 4 for SBC and AIC respectively. Therefore the models adopted 2 lag lengths based on SBC as it would give the most parsimonious model.

Table 3: Selection Order Criteria based on AIC and SBC

Lag	**MODEL 1**		**MODEL 2**	
	AIC	**SBC**	**AIC**	**SBC**
0	11.1768	11.3582	7.20944	7.34549
1	5.04112	5.94809	0.450105	0.994289
2	2.087	3.71955*	-0.769581*	0.182742*
3	1.78686	4.14499	-0.54452	0.815941
4	1.26874*	4.35246	-0.738717	1.02988

*Note: * denotes optimal lag length*

Source: Data generated using Stata 14.

4.4 Long-run and Short-run Analysis

The long run and short run results of the model are shown in table 4 below.

Table 4: Empirical Results for the ARDL Model 1 and Model 2

Model	Model 1 (dependent variable is GDPGR) ARDL (1, 0, 0, 1) based on SBC		Model 2 (dependent variable is GDPGR) ARDL (1, 0, 2) based on SBC	
Long Run Coefficients				
Regressor	Coefficient	T-Ratio [Prob]	Coefficient	T-Ratio [Prob]
PDGR	5.0474**	2.0536 [0.049]	-	-
HCIGR	-10.3929**	-2.0831 [0.046]	-	-
GCFGR	0.21170*	3.4377 [0.002]	-	-
WAGR	-	-	-4.0356***	1.9200 [0.065]
DEPGR	-	-	1.3574	0.87205 [0.264]
C	0.055176	0.15896 [0.987]	14.5364**	2.3989 [0.023]
Short Run Coefficients				
ΔPDGR	3.6122***	1.9790 [0.057]	-	-
ΔHCIGR	-7.4376***	-1.9396 [0.062]	-	-
ΔGCFGR	0.066420**	2.4996 [0.018]	-	-
ΔWAGR	-	-	-2.1371***	1.9200 [0.064]
ΔDEPGR	-	-	1.8691	0.87205 [0.390]
ΔDEPGR 1	-	-	-6.6084*	-2.9375 [0.006]
ECM (-1)	-0.71565*	-4.8666 [0.000]	-0.52956*	3.6797 [0.001]
	MODEL 1		MODEL 2	
R-Squared	0.50494		0.45101	
R-Bar Squared	0.41959		0.35636	
F-statistic	7.3947 [0.000]		5.9561 [0.001]	
Equation log Likelihood	-66.8365		-68.6461	
DW Statistic	1.8781		1.8282	
SE Regression	1.7945		1.8897	
Residual Sum of Squares	93.3822		103.5551	
Akaike Information Criterion	-72.8365		-74.6461	
Schwartz Bayesian Criterion	-77.5026		-79.3121	

*Note: *, ** and *** denote statistical significance at 1%, 5% and 10% respectively.*

Source: Data generated using Microfit 5.50

In model 1, the results in the table 4 above show that population density growth affects economic growth positively. As population density increases by one percent, economic growth increases by

5.05 percent in the long run and 3.61 percent in the short run. The results also indicate that human capital affects economic growth negatively. As human capital increases by one percent, economic growth declines by 10.39 percent in the long run and 7.44 percent in the short run. The results indicate that investment growth affects economic growth positively. As investment increases by one percent economic growth increases by 0.21 percent in the long run and 0.07 in the short run. The estimated value of R^2 was 50.49 percent and that of adjusted R^2 was 41.96 percent which approves that the model is good fitted. The error correction term coefficient is negative as expected and is highly statistically significant at 1 percent significance level which implies that disequilibrium can be adjusted to the long run equilibrium in the current year with a speed of 71.57 percent, having any shock in the previous year in the dependent variables.

In model 2, the results indicate that working age population growth affects economic growth negatively. As working age population grows by one percent, economic growth reduces by 4.04 percent in the long run and 2.14 percent in the short run. The results also indicate that dependent population growth affects economic growth positively in the current year. As dependent population grows by one percent, economic growth increases by 1.36 percent in the long run and 1.87 percent in the short run. However, in the short run, an increase by one percent of the previous year's dependent population reduces economic growth by 6.6 percent in the current year.

4.5 Diagnostic Tests

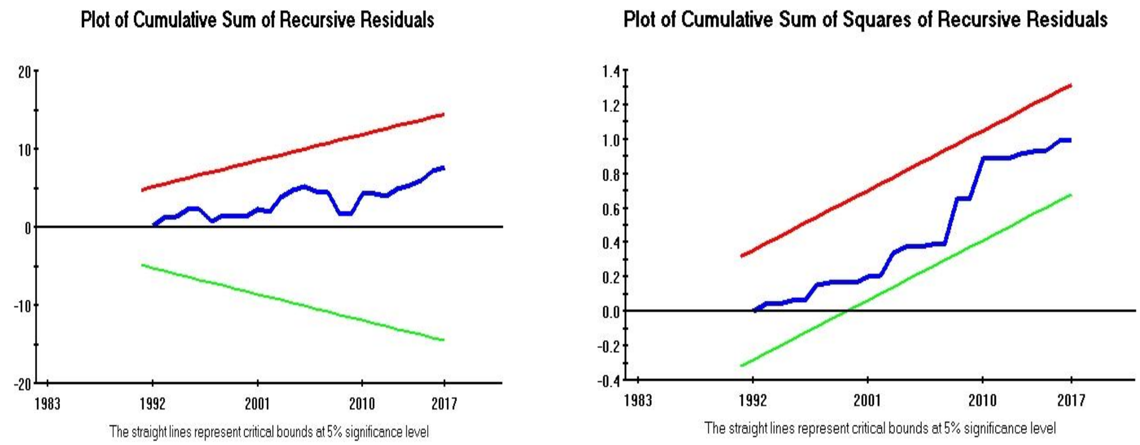
Post estimation diagnostics tests were performed on the models i.e. serial correlation, functional form, heteroscedasticity and normality. The results indicate that Model 1 passed heteroscedasticity, serial correlation and functional form but failed normality. Model 2 passed all diagnostic tests. Nevertheless, plots of cumulative sum of squares of recursive residuals (CUSUMSQ) and cumulative sum of recursive residuals (CUSUM) show that the models are stable at 5% level of significance. This confirmed the accurateness of long run and short run parameters which affect economic growth over the period 1981-2017.

Table 5: Post Estimation Diagnostic Tests for Models 1 and 2

Test Statistics	LM Version	
	MODEL 1	MODEL 2
Serial Correlation	0.24283 [0.622]	0.50904 [0.476]
Functional Form	0.97368 [0.324]	1.3306 [0.249]
Normality	6.1967 [0.045]	2.4648 [0.292]
Heteroscedasticity	0.066051 [0.797]	0.54371 [0.461]

Source: Data generated using Microfit 5.50

MODEL 1



MODEL 2

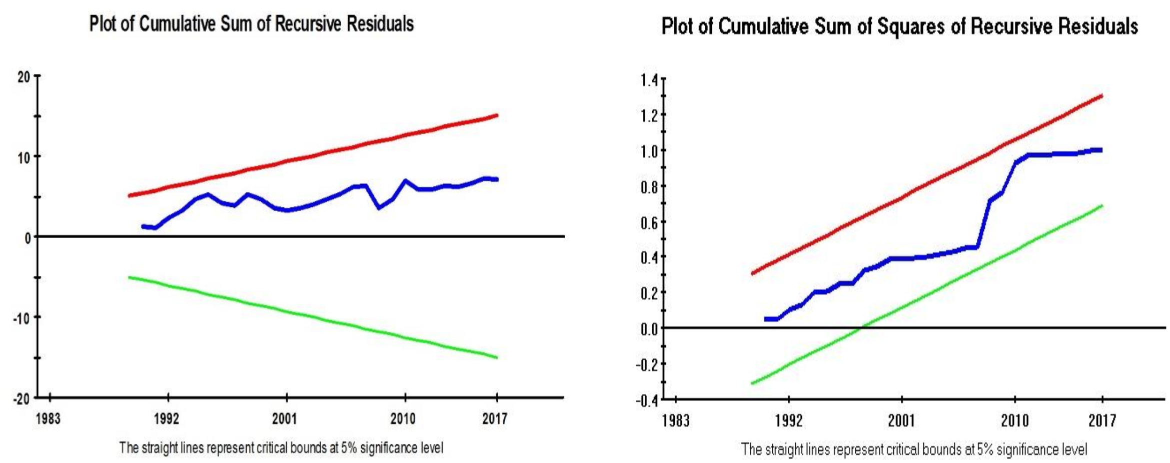


Figure 7: CUSUM and CUSUMSQ Plots

Source: Plots generated using Microfit 5.50

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter gives summary of the findings of the study and gives conclusions based on the findings. Policy suggestions from the empirical results are also made.

5.2 Summary

The study's main objective was to examine how changes in population density affect economic growth. It also explored how changes in working age and dependent population affect economic growth.

For the objectives of the study to be achieved, data on several macroeconomic variables was collected over the period 1981 to 2017 from World Bank Development Indicators Database and Penn World Table 9.1. Statistical softwares Stata 14 and Microfit 5.50 were used to analyze the data. A suitable theoretical growth model that found the basis of use of variables in the empirical model was derived.

The study's first objective was to determine the causal relationship between population density growth and economic growth in Kenya. The main interest was to explore if population density growth causes economic growth or economic growth causes population density growth. The results of the study revealed that there was presence of bi-directional causality implying that population density growth causes economic growth and also economic growth causes population density growth. This was proved by the error correction model being statistically significant at 1 percent. The study revealed a positive relationship between population density growth and economic growth.

The second objective of this study was to explore whether the relationship between population density growth and economic growth was a short run or a long run occurrence. The results revealed that population density growth affected economic growth positively both in the short run and long run. Other control variables used: per capita human capital growth and gross capital formation growth had different effects on economic growth in Kenya. Per capita human capital growth affected economic growth negatively while gross capital formation growth contributed positively to economic growth.

The third objective was to investigate how changes in working age population and dependent population affect economic growth in Kenya. This study revealed a negative relationship between working age population and economic growth. The results also showed that dependent population related positively with economic growth.

5.3 Conclusions

The study finds significant impact of population density growth on economic growth during the period 1981 to 2017. It also finds significant impact of human capital growth, gross capital formation growth, working age population growth, dependent population growth on economic growth.

5.4 Policy Suggestions

The results of the study reveal a positive and significant relationship between population density growth and economic growth in Kenya. Therefore, a well-planned institutional and policy changes could be considered to utilize the variations in population density in Kenya. The Kenyan government should put efforts to ensure that changes in population density contribute positively to economic growth by considering policies that are geared towards improving technological and physical infrastructure. Population density creates links, demand and market size for technological inventions. Additionally, efforts to reduce unit transport cost should put so as to increase positive role of economies. The basic paradox is that in classical microeconomics there is an assumption of costless and symmetric market access by consumers. However, in reality transport costs makes them asymmetric under full competition among producers and distributors. Regulations should be put in place to create more competition among transporters in Kenya. This is attributed to the fact that transport costs cannot be eliminated even if profits are brought to zero. The cost of transport is composed of: depreciation of vehicle, labour cost and fuel cost. Ceteris paribus, in the environment of labour markets, competitive firms and producers of vehicles, the fuel cost creates the difference. This remains the reason why economies concerned are sensitive to fluctuations in prices of oil.

The results of the study also revealed that human capital growth affected economic growth negatively while gross capital formation growth affected economic growth positively. This implies that the increase in human capital stock has to be harmonized by a consumerate increase in physical capital for human capital to contribute to economic growth positively. The potential linkage between human capital and other forms of capital, growth and income need to be considered in efforts to understand the part played by human capital as an input in economic development. Although human capital plays a significant role, this role may be vitiated unless policies enhance quick investment in other forms of capital.

In addition, the results of the study showed that increase in working age population affected economic growth negatively while increase in dependent population affected economic growth positively. Therefore, more efforts should be put towards considering policies that enhance creation of decent and adequate job opportunities that will enhance absorption of the working population. Also, domestic workforce should be paid handsomely to mitigate brain drain which has some adverse effects in some sectors of the economy especially health. Collaboration and support on the job and need based training should be enhanced to mitigate on mismatch between workforce skills and new employment opportunities. These efforts will utilize and make the working age population contribute positively to economic growth. Additionally, efforts should be made to ensure that the retirement age for productive aging workforce is extended as they contribute positively to economic growth.

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APPENDICES

Appendix 1: Refined Data for Estimation

Year	GDPGR	WAGR	DEPGR	PDGR	HCIGR	GCFGR
1981	3.773544	3.870387	4.000017	3.938960	1.488887	-4.723194
1982	1.506478	3.925106	3.954688	3.940818	1.488895	-22.720808
1983	1.309050	3.981550	3.867226	3.920959	1.488888	-9.947440
1984	1.755217	4.057182	3.717411	3.877237	1.488887	0.717020
1985	4.300562	4.134817	3.532532	3.816252	1.488886	28.027789
1986	7.177555	3.933816	3.586115	3.750461	1.488888	-18.359480
1987	5.937107	4.041684	3.360735	3.683107	1.488888	22.241416
1988	6.203184	4.118813	3.146591	3.608502	1.488890	1.764421
1989	4.690349	4.178462	2.932363	3.527192	1.488888	10.133178
1990	4.192051	4.233113	2.711072	3.442263	1.488884	-6.994896
1991	1.438347	4.141393	2.626662	3.359976	1.319352	-7.845061
1992	-0.799494	4.267401	2.340377	3.280219	1.268752	-18.223723
1993	0.353197	4.308905	2.122001	3.198825	1.268740	14.969075
1994	2.632785	4.233177	2.008257	3.115566	1.268746	9.087387
1995	4.406217	4.092079	1.963545	3.034410	1.268744	8.404142
1996	4.146839	3.728749	2.159684	2.957182	1.268740	9.983114
1997	0.474902	3.488862	2.261334	2.889891	1.268745	8.547343
1998	3.290214	3.377851	2.264745	2.838039	1.268742	20.783248
1999	2.305389	3.432541	2.129509	2.804170	1.268748	-8.134280
2000	0.599695	3.547644	1.953762	2.784014	1.268742	11.114144

2001	3.779906	3.111655	2.383421	2.765601	1.129287	12.121443
2002	0.546860	3.352170	2.079264	2.749517	1.129287	-20.374225
2003	2.932476	3.457679	1.946004	2.746628	1.129291	10.005568
2004	5.104300	3.381212	2.046162	2.758130	1.129279	7.627532
2005	5.906666	3.233998	2.248146	2.777108	1.129292	13.240486
2006	6.472494	3.157629	2.373945	2.796300	1.129291	31.473949
2007	6.850730	3.015928	2.561454	2.807230	1.129288	8.158528
2008	0.232283	2.957697	2.626321	2.805901	1.129280	14.136223
2009	3.306940	3.038930	2.492448	2.789039	1.129290	11.092918
2010	8.405699	3.181166	2.257460	2.759991	1.129281	11.371937
2011	6.108264	3.150981	2.223931	2.730353	0.894765	6.566664
2012	4.563209	3.313327	1.951522	2.698577	0.894762	9.400074
2013	5.878681	3.402951	1.729999	2.653191	0.894753	-0.311662
2014	5.357126	3.390710	1.593637	2.592437	0.894760	10.851021
2015	5.718507	3.331946	1.493410	2.523072	0.894760	5.007426
2016	5.878949	3.296319	1.354323	2.450361	0.894763	-4.447480
2017	4.862538	3.234115	1.262565	2.384462	0.894759	9.302514